Curb Your Innovation:
On the Relationship Between Innovation and Governance Structure[*]

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Abstract

In this paper, we analyze the relationship between innovation and firms' governance structure. We present and analyze a simple model in which the firm's governance structure influences the behavior of innovative employees and, in turn, innovation brings about changes to the firm's governance structure. Central to our analysis is the notion that power and rent sharing are reassessed when new ideas are implemented. The new rent allocation is determined by the ex-post bargaining power of all players involved in the new project. We highlight two problems that the owners of firms face in these situations. First, the tendency of owners to expropriate the rents of innovators often leads innovators to leave firms before revealing their ideas internally. Second, the fear of intra-firm rent redistribution brought about by innovation often results in conservative attitudes among the firm owners. After illustrating how our model captures these two problems, we disscuss how alternative decision-making protocols, such as delegating authority to a CEO or decentralizing the decision-making process of the firm, can help to mitigate them. These results are consistent with patterns of innovation and governance observed in the high-tech industry.

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1 Introduction

Innovation brings about change. The so-called "gales of creative destruction" change the configuration of firms, markets and industries. Firms are affected in two fundamental ways. First, the introduction of a new idea changes the market structure in which the firm operates. This could mean a better standing of the firm within the existing market or a strong role in a new market. However, the firm's position could be challenged if, as a result of innovation, a new firm spins out and generates market competition.

Second, innovation brings about changes to the internal structure of firms. Often, when the firm adopts important innovations, it re-evaluates its ownership and governance structure. New players, such as innovators, financiers or new management, come into the picture, while the position of the old ones is reconsidered. The new configuration is determined by the new distribution of power in the firm.[1]

If we look at a firm as an individual decision-maker, as long as the benefits of innovation offset the R&D costs, innovation should always be encouraged. However, firms are typically composed of a variety of decision-makers. These decision-makers anticipate the changes that innovation will bring to the market and to the internal structure of the firm and, as a result, they may have a more heterogeneous set of attitudes towards innovation.

The objective of this paper is to analyze the relation between the firm's organization and these attitudes towards innovation. In particular, we offer a model to study the effects of innovation on the firm's organization. Using this model, we tap into the opposite effect: we analyze how the firm's structure determines its attitude toward innovation and the actions firms can take to either curtail or promote it.

Our model formalizes the two effects of innovation on firms discussed above. To do this, we focus on the flow of new information as the channel through which innovation affects firms. In particular, we start with the observation that any individual with a new idea must share it with others in order to implement the idea within or outside a firm (*"information leakage"*). In turn, in the absence of perfect intellectual property rights, information sharing implies the sharing of control and rents among all those who know about the idea.

Central to our analysis is the notion that power and rent sharing are reassessed when new ideas are implemented. The new rent allocation is determined by the ex-post bargain-

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[1]One manifestation of such changes is the so-called "founders' syndrome" in which original founders of firms find themselves marginalized as the firm goes into new paths. See, for instance, McNamara (1999).

ing power of all players involved in the new project. As a result, innovation brings about changes that depend on the ex-post allocation of information. Because new ideas, by their nature, are difficult to forecast and define, these changes cannot be contracted on ex-ante.

We first focus on an agent who becomes inspired with a new idea while working in an established firm. In the model, this agent must choose among three courses of action. First, he may decide to disclose the new idea within the firm (*"internal disclosure"*). In this case, an intra-firm renegotiation arises and, if the new product is implemented, the firm's value will increase. Alternatively, the agent can decide to leave the original firm, bargain with his new recruits on a rent-sharing scheme, and form a *spin-out* firm that will compete to some degree with the original firm. Finally, the agent may decide not to disclose the new idea and to keep his current compensation plan in the original firm.

Several factors affect the employee's decision. First, market structure considerations come into play. If the idea stays within the firm, the surplus is maximized as the firm will enjoy monopoly profits for both the original and the new products. In contrast, if the employee forms a new firm, some rents may be lost due to competition between the original and the new firms.

Second, the organization and corporate governance structure of the original firm are important. By forming a new firm, the employee can create his own procedure for negotiating with his hires. In contrast, by staying in the original firm, the employee has to follow the firm's organizational procedures. In the absence of perfect legal protection, this could lead to excessive rent expropriation. This implies that the governance structure of the original firm may influence the employee's decision about whether or not to introduce a new idea within the firm. In our model, we use the number of people the innovator has to involve in the approval of the new project to capture these aspects of the firm's organization. As this number varies, the information leakage patterns vary as well, leading to different possible outcomes for the innovator.

Proposition 1 states that as the number of people one has to approach within the firm increases, the employee is more inclined to leave the firm. This result is simple, but raises some important issues that we explore in the paper. First, one can interpret this result as a formalization of the tendency of large, established firms to stagnate. A big portion of the innovation in the high-tech industry occurs through the formation of spin-outs, often implying substantial losses for their maternal firms.[2] At the same time, innovation tends

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[2]This phenomenon motivated Christensen (1997) to coin the term "disruptive technology."

to slow down in established firms.[3] This phenomenon has been termed "The Curse of Incumbency," that is, existing market leaders are typically slower than entrants to see and adopt new technologies. As a result, technological change often enables challengers to enter a market and displace its leaders. Our model offers a simple but clear relation between the firms' size or bureaucracy level and the amount of innovation they implement.

Proposition 1 also predicts that employees sometimes choose not to implement their ideas. Therefore, by providing employees with generous compensation and favorable career perspectives ex-ante, a firm has the possibility to discourage innovation. The intuition for this result is the following. An employee compares his current continuation value of staying in the firm with what he expects to get once he introduces the idea within the firm or via a spin-out. The continuation value of remaining silent includes all the current and future benefits for the employee, including his expected career path within and outside the firm. Once he either reveals the idea in-house or forms a new spin-out, his continuation value is determined by his new (ex-post) bargaining position. If the continuation value of remaining silent exceeds that of revealing the idea, the employee will choose to remain silent.

Under what circumstances do firms have an incentive to curtail innovation? To answer this question, we need to model the firm's corporate governance explicitly. First, we assume that ownership and control coincide, and a favorable vote by the shareholders is required to implement innovation within the firm.

Corollary 1 describes the effect of ownership structure on the employee's decision. When ownership and control coincide, the number of people involved in the renegotiation depends on the number of shareholders. In a firm in which ownership is concentrated (the number of shareholders is small enough), a small set of people is involved in decision-making, and one expects employees to disclose ideas within the firm rather than form spin-outs. In dispersed-ownership firms, when the number of shareholders controlling the firm is large enough, one would expect to see more spin-out formation.

At this point, we are able to address the question about the incentive to promote or discourage innovation within the firm. From the point of view of the original firm, the results, so far, suggest that innovation entails two sources of changes. First, employee defection may hurt the firm's market position by introducing new competition into the market (*"market competition effect"*). Second, even if an employee remains in the firm,

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[3]Foster and Kaplan (2001) document that among the firms listed in the S&P 500 in 1957 only 2% are still listed and outperformed the index average in 1997, 13% are still listed but underperformed it, while 85% were off the list.

the introduction of new ideas entails a reshuffling of rents within the firm (*"reshuffling effect"*).

We find that the dispersion of ownership affects the firm's attitude toward innovation. Our analysis shows that shareholders of both dispersed and concentrated firms sometimes find it optimal to discourage innovation, but they differ substantially in their motivation for doing so. Dispersed firms are less concerned than concentrated firms about the reshuffling effect. As a result, when internal disclosure is expected, dispersed firms tend to encourage it, while concentrated firms sometimes try to prevent it. Indeed, the owners of a concentrated firm face the following trade-off: an internal disclosure would increase the rents appropriated by the firm; at the same time, however, the ex-post rent allocation entails a lower expected value for them if the number of people innovation brings into the picture is high enough.

Our results suggest that innovation will be discouraged even when it would be efficient from the firm's point of view to encourage it. This inefficiency arises from two problems that the owners of firms face in these situations. First, the owners' tendency to expropriate the rents of innovators often leads innovators to leave the firm before revealing their ideas internally. Second, the fear of intra-firm rent redistribution brought about by innovation often results in conservative attitudes among the owners of a firm. In Section 5, we discuss how the owners can mitigate these problems by committing to alternative modes of governance, such as delegating authority to a CEO or a hierarchy of managers. We also consider some common compensation scheme for CEOs and we study the effects these schemes have on the CEO's incentives to innovate.

A large body of literature has focused on the special organization and culture of firms in Silicon Valley, where many of the changes we study have indeed occurred. Substantial emphasis has been given to the way start-ups have organized to facilitate innovative activity.[4] These start-ups are often characterized by egalitarian means of governance and ownership. Employees typically receive shares and profit-sharing compensation schemes, and the firms' hierarchical structure tends to be relatively flat and decentralized compared to that of firms in other regions.[5]

To compare what alternative organization structures imply for different types of inno-

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[4] Different explanations have linked the way firms were organized to the success of the region: the democratic, non-hierarchical organization design facilitated information flows and creativity within the firm.

[5] See also Rajan and Wulf (2005).

vation, in Section 4.1.1 we illustrate our results in different market settings. We consider three types of innovation (related to different stages in the life of a new industry) that differ in the ex-post market structure once the innovation is introduced. For every type of innovation, we analyze the level of innovative activity coming out of the different firm types. First, we consider innovation that does not disrupt the market of the old product ("independent innovation"). We find that dispersed firms always promote this kind of innovation, while concentrated firms sometimes try to prevent it. Second, we consider innovation that wipes out the old product market ("vertical innovation"). Since the threat of spin-out formation is very severe in this case, dispersed firms tend to be more conservative than concentrated firms. Finally, we consider an innovation very close to the old product ("horizontal innovation"). Since, here, the threat of spin-out is not credible, we show that dispersed firms are more innovative than concentrated ones.

The paper is structured as follows. After a literature review, we introduce the model in Section 2. In Section 3, we study the innovator's problem taking the corporate governance structure and the employee's compensation scheme as given. In Section 4, we assume that the owners control the firm and we analyze the firm's incentives to promote innovation. In Section 5, we discuss more general models of corporate governance and in Section 6 we conclude.

1.1   Literature Review

To our knowledge, this paper is the first to analyze the reciprocal relation between innovation and the firm's organization structure. Below we list some papers that relate to different aspects of our analysis.

The informational concerns of an individual innovator are analyzed in Anton and Yao (1994), Baccara and Razin (2003), d'Aspremont, Bhattacharya and Gerard-Varet (2000) and Bhattacharya and Guriev (2004).[6] The patterns of incremental research and worker mobility have been analyzed in works by Scotchmer (1991 and 2005), Anton and Yao (1995), Klepper (2001), Franco and Filson (2002) and Lewis and Yao (2003). Among these, the most relevant reference for our approach is Anton and Yao (1995), which focuses on an innovator's decision regarding whether to leave the firm and form a spin-out. While this

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[6]Bhattacharya and Guriev (2004) compare alternative sale mechanisms (open or closed sale) of R&D knowledge. d'Aspremont, Bhattacharya and Gerard-Varet (2000) analyze some aspects of the problem of bargaining over the disclosure of interim research knowledge. See also Rajan and Zingales (2001).

paper shares our emphasis on information leakage as the determinant of the expropriation of rents, it does not explore the link between governance structure and innovation.

Several aspects of spin-out formation, which are different from the focus of this paper, have been analyzed by Pakes and Nitzan (1983), Hellman and Perotti (2005), Hellmann (2005) and Franco and Mitchell (2005). Pakes and Nitzan (1983) analyze the optimal contract problem for personnel that may leave the firm to form spin-out enterprises. Hellman and Perotti (2005) model the difference between intra-firm innovation and innovation through spin-out as a difference in the level of protection of intellectual property rights. Hellmann (2005) provides a model that describes how alternative corporate policies can affect the rate at which new ideas are generated. Finally, Franco and Mitchell (2005) study the impact of the legal environment (and, more precisely, the presence of "Covenant not to Compete") on the rate of spin-out formation.

A recent series of empirical papers which explore the patterns of decentralization and flattening hierarchies over time is related to the analysis in Section 5. In particular, Rajan and Wulf (2005) study firms' hierarchy and found that over time intervening managers have been eliminated and replaced by CEOs who are more involved in decision-making in lower tiers of the hierarchy. Acemologru and al. (2006) show how decentralization is more likely to occur in firms that are closer to the technological frontier, are more heterogeneous and are younger.

Finally, our analysis formalizes the notion that large established firms are often stagnant and prone to dissolution by small innovative spin-outs ('The Curse of Incumbency'). Explanations for this puzzle are often based on unawareness or bounded rationality of established firms when making decisions regarding new technologies. In particular, Christensen (1997) suggests that established firms tend to focus too much attention on their current customer base, not realizing that existing customers are not necessarily the best predictors of tomorrow's market trends.[7] In contrast, we offer a rational decision-making model in which the size and structure of the firm are directly linked to the vulnerability of the firm with respect to employee defection.

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[7]See also Välikangas and Gibbert (2005).

2 The Model

Assume that there is a firm producing a patented product, and the production requires labor as input. Let us assume for simplicity that in order to produce, the firm needs to hire exactly one employee. There is an infinite supply of potential employees, and their reservation value is zero.

While working in the firm, the employee is inspired with an idea for a new product. Then, the employee has to choose whether he wants to disclose his idea within the firm, leave the firm and form a spin-out, or remain silent and keep on working for the firm. We define as v the (expected) value of the worker if he stays in the firm and remains silent. This value includes any expectation the employee has about his payoffs and career path within the firm, given that he has not disclosed his idea. Note that some elements included in v are contractible, while others are not. We assume that the decision-makers in the firm can control v.

As we mentioned above, the new idea can be implemented either within the firm or with an independent spin-out. In the next section, we discuss how the bargaining over the market rents enfolds in the two cases. Let us now specify the market outcomes depending on the outcome of the innovator's decision. As the new product competes to some degree with the old product, the profits of the firms in the market are as follows: (i) one firm producing only the old product enjoys a rent of $\pi \in (0, 1)$ per period; (ii) one firm producing both the old and the new products receives a rent of 1; (iii) if one firm produces the old and another produces the new product, they receive π_1 and π_2, respectively.[8] We assume that $\pi_1 + \pi_2 < 1$, that is, configuration (ii) realizes the greatest joint profits. Finally, we assume that if there is more than one firm in the new product market, Bertrand competition dissipates all the profits.[9] This assumption captures the fact that it is difficult for intellectual property rights to protect new ideas effectively.

In our analysis, we are interested in modeling the corporate governance structure of the original firm explicitly. Since we focus on bargaining with information leakage, an important aspect of any bargaining outcome is the number of people that must be involved in a negotiation. Let $n \geq 1$ be the minimal number of people that need to approve a new product line within the existing firm in order for it to be implemented. When the owners

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[8] For simplicity, we assume that a patent on the old product guarantees that there cannot be two firms producing it.

[9] Notice that, in general, when there is Bertrand competition on the new product, the old firm can still earn some $\pi_1' < \pi_1$ from the old product. For simplicity, we assume $\pi_1' = 0$.

of the firm are the only decision-makers, n is the number of shareholders needed to approve an innovative project within the firm. In general, this number depends on the number and distribution of shareholders of the firm. This is the view we take in Section 4, where we assume that unanimity among the shareholders is needed to approve a new project (thus, n is simply the number of shareholders), and all the shareholders own an equal share of the firm.[10] In general, when ownership and control do not coincide, this number may depend on factors such as the level of bureaucracy and decentralization in the firm. We take this more general perspective in Section 5.

2.1 Bargaining on new ideas

Central to our methodology is the notion of information leakage. For an innovator, the development process of a new idea involves collaboration, information sharing and, as a result, the loss of full control. In Baccara and Razin (2003), we analyze a bargaining protocol consistent with this view and study its implications for the distribution of the rents in a firm.

In this paper, rather than specifying a bargaining protocol, we simply assume that any rents from innovation are equally divided among all those who learn about a new idea–that is, all those involved in its approval and development.[11] This implies that innovators always lose some of the rents to those who help them to approve or develop the idea.

We assume that in order for the idea to be developed, $m > 0$ agents are required to be involved in the project. The parameter m represents the players whose skills or resources are necessary for the implementation of the idea. They could be technical staff, financiers or managers, and they could be members of the original firm or any other agent out of the infinite pool of potential co-workers. An employee who is inspired with a new idea can either make an offer to any number of other agents that is larger or equal to m, or can remain silent. If he remains silent, the game ends, the innovator gets v and the original firm has a payoff of $\pi - v$.

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[10]None of the result depends on the unanimity and symmetry assumptions, which could be easily relaxed with any other voting rule according to which the number of votes needed n weakly increases with the number of shareholders. In this case, n would depend on the distribution of shares among the shareholders. Note also that this assumption could be fitting for small start-up firms in which there is a close relation between ownership and control. Moreover, when an innovation is very important, the main owners of the firm are likely to be involved in the implementation decision.

[11]This assumption is consistent with the results in Baccara and Razin (2003) in the case of strong competition on the new product market, which is among the assumptions we formulated before.

We refer to an offer that includes the n agents required to introduce the new product within the original firm as an *internal disclosure*, and to any other offer as a *spin-out*.[12] In Section 4, where we assume that the unanimity of the shareholders is needed to approve a new project, and all the shareholders own an equal share of the firm, every owner of the original firm has his share of the value of the firm if the firm quits the negotiation (i.e., $\frac{\pi_1}{n}$), as an outside option in the bargaining with the innovator.[13] If a spin-out is formed, the innovator (and his group) will leave the original firm and start a new firm.

In Section 5, we consider the case of a manager(s) controlling the firm. We assume that the owners allow the managers to distribute a budget B either ex-ante (before innovation) or ex-post. The parameter B is a measure of the discretion of the firm's managers.

2.2   Timing

The timing of the game is as follows. The original firm hires an employee and promises him a payment v. While working for the firm, the employee has an idea for a new product. The employee then decides whether to disclose his idea internally, form a spin-out, or remain silent.

If the innovator remains silent, the game ends. In this case, the firm owners receive a payoff of $\pi - v$, and the employee's payoff is v.

If the innovator chooses an internal disclosure, the original firm realizes a profit of one on the market. The ex-post bargaining division of the rents depends on the firm's corporate governance structure. If the owners control the firm, then the value of the firm is divided evenly among the shareholders and the innovator. If managers control the firm, as we assume in Section 5, the agents involved in the ex-post renegotiation divide evenly with the innovator the budget B, and the initial shareholders of the firm divide $1 - B$ according to their original shares.

If the innovator chooses to form a spin-out, the original firm realizes π_1, which is divided according to the initial distribution of the shares, and the spin-out realizes π_2, which is divided equally among the agents involved in the formation of that firm.

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[12]Notice that, according to this definition, an agent can form a spin-out also by making an offer to some set of agents that are part of the original firm, as long as the set does not include the coalition of the decision-makers.

[13]Note that even if the original firm learns about the new idea and quits the negotiation, it can always guarantee itself a profit π_1 by keeping on producing only the old product.

3   The Innovator's Dilemma

In this section, we focus on the problem an employee faces after he is inspired with a new idea. Recall that such an employee can expect to receive a continuation value v from the original firm if he does not disclose the new idea. Alternatively, the employee can decide to implement his idea either within the firm or through the formation of a spin-out.

The following result characterizes the employee's optimal decision.

Proposition 1 *There is a $\overline{v}$ such that (i) if $v > \overline{v}$, then the innovator does not disclose his idea at all, (ii) if $v < \overline{v}$, then the innovator will leave the firm and form a spin-out if n is high enough; otherwise, he reveals the idea within the firm.*

The intuition of Proposition 1 is simple. If an employee with a new idea leaves the firm to form his own venture, he will get $\frac{\pi_2}{m+1}$ (as will any other agent included in the spin-out). Instead, if he opts for an internal disclosure, any agent involved in the bargaining and the innovator get $\frac{1}{n+1}$ if $n \geq m$, and $\frac{1}{m+1}$ otherwise.[14] If he stays in the firm and does not disclose his idea, he gets v. So, his optimal choice is determined by the highest payoff. Notice that the innovator is more likely to form a spin-out the higher is n.

Proposition 1 has a few important implications. First, sometimes the efficient outcome (internal disclosure) is not achieved. This is because of the presence of *information leakage,* which modifies the employee's bargaining power within the firm as soon as the renegotiation starts. When he is inspired, the employee might decide to leave the firm and form a spin-out, rather than go back to his employers to renegotiate his compensation to reach the bargaining-efficient outcome. In addition, he might decide to stay silent to avoid jeopardizing his compensation plan v.

Second, sometimes ideas will not be disclosed at all. At first sight, this might seem counter-intuitive: how can an employee be worse off by disclosing an idea within his firm? Remember that v represents the continuation value of the employee in the current status quo of the firm. The introduction of a new idea may require that many people will learn about it and this might lead to some defection. This could hurt the current standing of the firm and its ability to provide the employee with what he expected ex-ante. Second, even if no one defects from the firm, the mere possibility that someone might do so could entail a new distribution of power in the firm that hurts the employee's current position

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[14]If $m > n$, the decision-makers in the firm are not sufficient to develop the project by themselves, and new agents must be brought to the bargaining table for the innovation to be implemented.

(especially if the firm takes on a new direction that is not in line with his expertise). In the model, these possibilities are captured by the assumption that the *ex-post* distribution of bargaining power (due to knowledge of information) determines the payoffs of all players. Then, if the firm's governance structure requires an employee to share his idea with many others, this employee may find himself marginalized in the new configuration of the firm to such an extent that he could be worse off.[15]

Finally, Proposition 1 implies that the firm's structure and size (here captured by the parameter n) affect the innovator's decisions of whether to leave and form a spin-out. In particular, innovators face a trade-off. Internal disclosure is beneficial as it avoids the dissipation of rents to competition. As a result, total rents are maximized. On the other hand, internal disclosures may imply the sharing of rents and control with more individuals than when forming a spin-out. When starting a spin-out, the innovator increases the degree of market competition but is not bound by any of the original firm's organizational prescriptions.

So far, we have not made any assumptions about what determines the parameter n. In general, this parameter stands for some notion of bureaucratic or hierarchical structure of the original firm. Under this view, the larger and more centralized the firm is, the more people become involved in any decision that needs to be taken. In turn, this affects the decisions of employees that perceive a loss of control for any innovation they want to implement within the firm. Another interpretation of the parameter n is related to the firm's ownership structure. Under this interpretation, the more diffuse the ownership structure, the more shareholders will be involved in any important decisions made in the firm. This is our approach in the next section, in which we analyze the shareholders' incentives with respect to innovative ideas.

4   Ownership and Innovation

The previous section illustrated the problem that innovative employees face when they have to decide whether and how to implement their ideas. This problem has an impact on the original firm's situation. In particular, there are two channels through which innovation can hurt the original firm. First, employee defection may hurt the firm's market position by

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[15]This situation is related to what has been termed the "founder's syndrome," in which innovators find themselves marginalized within the firm they created by new forces that were triggered by their initial innovation. See, for instance, McNamara (1999).

introducing new competition (*"market competition effect"*). Second, even when employees remain in the firm, the introduction of new ideas may entail changes in the firm's organizational and ownership structure. These changes imply a reshuffling of rents and control within the firm (*"reshuffling effect"*). The decision-makers of the original firm must assess the risk of these effects in anticipation of employees' innovation.

We want to illustrate how the shareholders' incentives regarding innovation depend on the ownership and corporate governance structure of their firm. To this end, we take a simple view of corporate governance by assuming that ownership and control coincide. For simplicity, we assume that the firm is governed by the unanimity of shareholders and that all the shareholders have the same stake in the firm (then, the parameter n represents the degree of dispersion of ownership of the firm).[16]

Proposition 1 implies that the structure of the firm affects the decisions of inspired employees. This is formalized in the next corollary.

Corollary 1 *There is $\overline{n}$ such that, if the new idea is implemented, it is always through an internal disclosure if $n \leq \overline{n}$ and through a spin-out otherwise.*

If the innovative employee implements the idea within the firm, he gets the minimum between $\frac{1}{n+1}$ and $\frac{1}{m+1}$, while if he forms a spin-out, he gets $\frac{\pi_2}{m+1}$. Then, $\overline{n}$ is defined as the maximum integer such that $\frac{1}{\overline{n}+1} \geq \frac{\pi_2}{m+1}$, and is such that $\overline{n} \geq m$. This implies that if $n \leq m$, an internal disclosure is always the dominant way to implement innovation. In the next section, we show that the ownership structure of firms affects the shareholders' incentives and, therefore, the decisions the firm will make regarding innovation.

4.1 Buying off Potential Innovators

In what follows we solve the firm's problem– that is, we analyze the choice of the optimal v given the behavior expected from the employee once he becomes innovative. We now assume that v is set by the controlling coalition of shareholders. Moreover, let us normalize the employee's value of not being in the firm to zero. This implies that the firm does not need to offer the employee a strictly positive value. As we will see below, sometimes the firm will have incentives to provide strictly positive values due to its concerns about the employee's future actions.

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[16]The quality of the results holds for alternative voting rules and more general distribution of shares in the firm.

Proposition 1 suggests that the firm can use the variable v as a tool to influence the employee's decision. To see this, suppose that when an agent is inspired with a new idea, the best course of action (excluding the possibility of remaining silent) will lead to a payoff of $\widetilde{v}$. Alternatively, by remaining silent the employee can always guarantee himself a continuation value of v. Thus, a firm has the possibility to *"buy off"* the innovative employee and discourage the implementation of the new idea. In particular, if the firm decides to buy the employee off, it will set the current compensation of the employee at $v = \widetilde{v}$. This will guarantee that when the employee has an idea, the idea will not be implemented.

Two points deserve attention at this point. First, note that v has to be set *before* the inspiration occurs. Indeed, the firm cannot rely on the agent to come back and renegotiate his compensation ex-post because, as we pointed out in Proposition 1, the presence of information leakage might induce the employee to decide to leave the firm and form a spin-out, rather than go back to his employers to renegotiate his contract.

Second, the firm's ownership dispersion is important in this analysis for two distinct reasons. Because of Corollary 1, the number of shareholders affects the employee's choice of whether to introduce the idea in the original firm or outside this firm. Furthermore, the number of shareholders determines whether or not the firm has an incentive to buy the agent off or not to. In particular, if the shareholders in a dispersed enough firm anticipate that the employee is going to introduce the idea within the firm, it is in their interest to allow this to happen. On the other hand, the owners of a concentrated firm may want to discourage internal disclosure.

The following two Propositions highlight the difference between the incentives to innovate in dispersed and concentrated firms. First, let us address the case of a firm which is dispersed enough– that is, such that $n \geq m$.

Proposition 2 *Suppose that $n \geq m$. If an internal disclosure is expected, v is set at zero (there is no buying off) and the internal disclosure takes place. (ii) If a spin-out is expected, and $\frac{\pi_2}{m+1} \leq \pi - \pi_1$, then $v = \frac{\pi_2}{m+1}$ (buying off takes place) and the employee doesn't implement his idea. Otherwise, $v = 0$ and a spin-out forms in equilibrium.*

Proposition 2 guarantees that an internal disclosure is always encouraged if a firm's ownership is dispersed enough– that is, if $n \geq m$. As the new idea leads to profit gains, and all the shareholders are involved in the ex-post renegotiation, the reshuffling effect works in favor of all the owners. If the firm decides to discourage disclosure, it has to pay

the innovator enough to keep him indifferent between staying silent and disclosing his idea internally. This implies that shareholders always prefer that the value of the firm increases, even if they will have to share it with one more partner. Alternatively, when a spin-out is expected, the cost of buying off the employee depends on his payoff in a spin-out, i.e., $\frac{\pi_2}{m+1}$. If this cost is higher than the difference between the profit of the firm without innovation and the profit of the firm after the formation of a rival spin-out, buying off does not occur and a spin-out arises in equilibrium.

Corollary 1 and Proposition 2 have implications for the dynamic evolution of small firms. Small firms will tend to promote and encourage internal disclosure of ideas. As the firm grows and new shareholders are added in to implement the new ideas, we will observe that innovation in the firm will tend to stagnate. This arrest in innovation will be due either to the formation of spin-outs, if $\frac{\pi_2}{m+1} > \pi - \pi_1$, or to buying-off, if $\frac{\pi_2}{m+1} \leq \pi - \pi_1$.[17].

In the next result, we address the case in which innovation is anticipated in a concentrated firm–that is, a firm such that $n < m$.

Proposition 3 *If $n < m$, (i) if $\frac{1}{m+1} \geq \frac{\pi_1}{n}$, then buying off takes place if $\pi > \frac{n+1}{m+1}$– that is, if m is high enough; otherwise, $v = 0$ and internal disclosure occurs. (ii) If $\frac{1}{m+1} < \frac{\pi_1}{n}$, then buying off takes place if $\pi_1 < \frac{\pi(m+1-n)-1}{m-n}$–that is, if m is low enough; otherwise, $v = 0$ and internal disclosure occurs.*

From Corollary 1 we know that if $n < m$, forming a spin-out is never optimal for an innovator working in a concentrated firm. Therefore, a concentrated firm is never threatened by the market competition effect. However, Proposition 3 shows that the owners of a concentrated firm can still prefer to buy the innovative employee off because of the reshuffling effect. Indeed, when $n < m$, implementing the innovation requires to bring new agents into the firm (new financiers, suppliers, etc.), and the original owners of the firm may fear that their role will be reduced substantially in the ex-post renegotiation of the firm value. However,recall that the firm's original owners are protected by the fact that their outside option in the bargaining is the value they get if they veto the implementation of the new product, i.e., $\frac{\pi_1}{n}$.

For instance, suppose that $n = 1$ (the original firm has only one owner). If π_1 is small enough (i.e., the original owner's position in the bargaining is weak), in the absence of

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[17]The evidence linking spin-off rate and firm size is addressed by Franco and Filson (2002) and Feeser and Willard (1989). Also, Klepper and Sleeper (2000) and Klepper (2001) have shown an increase in spin-out formation as the parent firm ages in laser and biotechnology industries. In the laser industry, the spin-out formation rate eventually declines after the parent firm passes through middle age.

buying-off, the payoff for both the owner and the innovator is going to be $\frac{1}{m+1}$. Thus, if the owner wants to buy off the innovator, he has to pay the cost $\frac{1}{m+1}$ and he gets $\pi - \frac{1}{m+1}$. Buying-off occurs when $\pi - \frac{1}{m+1} > \frac{1}{m+1}$. Notice that before the disclosure, one shareholder owns almost the entire value of the firm. After the disclosure, the value of the firm increases, but the bargaining over the new idea entails a new, egalitarian ownership structure among all those involved in the development of the new idea. As the development of the idea requires more people (i.e., m is higher), the bargaining will involve more agents, and the share of each of them will be smaller. This implies that the owner has more incentive to deter the disclosure of the new idea by buying the innovator off.

On the other hand, if π_1 is high enough (that is, the original owner's outside option in the bargaining is binding), then, in case of an internal disclosure, the firm's owner will get π_1, while the innovator and all the new players will get $\frac{1-\pi_1}{m}$. Thus, the higher is m the cheaper it is to buy off the innovator, and, if buying off occurs, each owner of the firm gets $\pi - \overline{v} = \pi - \frac{1-\pi_1}{m}$. Then, buying off occurs if and only if $\pi - \frac{1-\pi_1}{m} > \pi_1$, or $\pi_1 < \frac{\pi m - 1}{m - 1}$. Note that this condition is more likely to be satisfied if m is low enough.

Finally, it is interesting to stress the difference between the cases in which an inefficient outcome arises in dispersed and in concentrated firms. In a dispersed firm, buying off occurs only to prevent a spin-out. When an internal disclosure is expected, the efficient outcome is always realized as the inn ovation stays in the firm and it is implemented. In the case of a concentrated firm, in which spin-outs are never expected, buying off can still occur because of the reshuffling effect, causing the firm to stop introducing innovation.

So far, our results have illustrated the differences between firms that have different ownership structures. In the next section, we evaluate which kinds of firms lead to more innovation in different environments.

4.1.1   Comparative analysis under different types of innovation

In this section, we explore the implications of our results for three important types of innovation.

Independent Innovation   We use *"Independent innovation"* to denote a situation in which the old and new products are independent of one another, and the introduction of the new product does not alter the profit generated by the old one– i.e. $\pi = \pi_1, \pi_2 > 0$.

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Proposition 4 *In the case of independent innovation, spin-out formation is never prevented and dispersed firms are more innovative than concentrated firms.*

Proposition 4 states that, in the case of independent innovation dispersed firms perform better than concentrated firms. Recall that dispersed firms buy off innovation only if spin-outs are expected to occur. However, since in this case $\pi = \pi_1$, innovation does not represent a threat for dispersed firms because no rents are lost due to the formation of spin-outs. As a result, there is never buying off, and innovation always occurs, either internally or through a spin-out. In contrast, concentrated firms sometimes buy off innovators because of the threat of the reshuffling effect.

Vertical Innovation "*Vertical innovation*" refers to situations in which the new product represents a clear improvement over the old one. In this case, when the new product is implemented, the market for the old product disappears– i.e. $\pi_1 = 0$ and $\pi_2 = 1$.

Proposition 5 *In the case of vertical innovation, concentrated firms are more innovative than dispersed firms.*

The intuition of Proposition 5 comes from the fact that, in the case of vertical innovation, the threat of spin-out formation for an egalitarian firm is very severe. If an egalitarian firm does not buy the innovator off, a spin-out will always emerge, and any profit of the original firm is going to disappear. As a result, a dispersed firm will buy off the innovator if and only if $\pi > \frac{1}{m+1}$. This implies that in this environment dispersed firms tend to discourage innovation relatively often and never experience internal disclosure. When potential innovation is relatively small, buying-off occurs and dispersed firms survive by continuing to produce the old product. If the potential innovation is important, dispersed firms tend to yield spin-outs that will wipe out their profits.

On the other hand, concentrated firms are not concerned with the formation of spin-outs but with the reshuffling of ownership in the firm.[18] In the absence of buying off, the owners of the original firm are still going to get the profit $\frac{1}{m+1} > 0$, and the buying off will occur if $\pi > \frac{n+1}{m+1} > \frac{1}{m+1}$.

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[18]Note that this is an extreme case in which the innovator in a concentrated firm is indifferent between forming a spin-out and an internal disclosure, so in what follows we assume that when he is indifferent, he will disclose internally.

Horizontal Innovation Finally, "*horizontal innovation*" describes the situation in which the new idea competes strongly with the old product– i.e. $\pi_1 = \pi_2 = 0$. An example of this situation could be an innovation in cost-reducing technology, resulting in a product that is quite similar to the old one.

Proposition 6 *In the case of horizontal innovation, dispersed firms are more innovative than concentrated firms.*

Proposition 6 follows from the observation that, in the case of horizontal innovation, a spin-out is never expected to occur in equilibrium, so the market competition effect does not arise. Hence, by Proposition 2, we know that a dispersed firm will always encourage such an innovation. On the other hand, a concentrated firm is going to be concerned about the reshuffling of ownership and control that will take place after the new idea is implemented. By Proposition 3, buying off will occur whenever $\pi > \frac{n+1}{m+1}$.

Stages of an industry Let us relate the results we described in this section to different stages of an industry. Independent innovation is more likely to arise in a young industry or economy in which a completely new technology is introduced (e.g., the Internet boom), many unexplored potential markets are available, and it is easy for innovators to find new products that are unlikely to compete with old ones (first stage). As the industry matures, the markets become more defined and the dimensions of potential innovation narrower (second stage). At this stage, one can expect vertical innovation to characterize a substantial number of innovations (e.g., Internet browsers and search engines). Finally, in a well established and highly competitive environment, the possibilities for breakthrough innovation are limited and horizontal innovation becomes the most likely one (third stage). If we reinterpret the type of innovations described above in this way, our analysis has shown that, in the first stage, dispersed firms will lead to more innovation than concentrated ones. When an industry is young, dispersed firms *always* promote innovation, either internally or through the formation of spin-outs. A high degree of both internal innovation (from relatively small firms) and spin-out formation (from larger firms) should be observed in this stage.

When an industry is more mature and enters in the second stage, concentrated firms are the most innovative. In this stage, the threat of spin-out formation is at its peak because their formation starts being detrimental to existing firms and, at the same time, spin-outs represents a credible threat to the original firm. While concentrated firms never find

themselves in this position because their employees tend to disclose their ideas internally, dispersed firms sometimes face the threat of spin-out formation and, then, can find it optimal to discourage innovation. Therefore, in order to keep the incentives geared toward innovation promotion, a firm should avoid a dispersed structure and move toward a more concentrated decision-making structure. Then, while spin-out formation is still observed in relatively large firms, more buying off should occur in this stage, so spin-out formation slows down with respect to the first stage.

When an industry is very mature and highly competitive, potential sources of profits are typically rare. In these cases, employees avoid forming spin-outs because innovation is not substantial enough to justify the introduction of more competition on the market. Then, the threat of spin-out formation is not credible for the original firm. Since dispersed firms always accommodate internal disclosure, they will encourage horizontal innovations that still can occur in such a market. On the other hand, if the ownership of the original firm is concentrated, innovation might be discouraged.

5 Governance and Innovation

In this section, we discuss the relationship between innovation and corporate governance in light of our previous results.

Our analysis so far suggests two reasons why a firm's owners may want to forgo control and change the way decisions about innovation are taken in their firm. First, when ownership is dispersed, potential innovators tend to leave the firm in fear that a large portion of the rents of their ideas is going to be expropriated. In this case, the firm's owners of the firm may want to *commit* not to be involved in the ex-post bargaining process.

Second, owners may be tempted to discourage innovation ex-ante due to the fear of changes brought about by internal innovation. These changes arise due to the ex-post renegotiation of contracts; innovators gain a strong bargaining position vis-a-vis the firm's original owners. In this case, as well, the owners may want to *commit* not to be involved in these ex-post negotiations. Indeed, they could insure themselves against the dissipation of their rents by delegating restricted authority to an agent who would be the one involved in negotiations.

The two problems illustrated above suggest that appointing a CEO may be beneficial from the owners' point of view. In a firm, the CEO takes both the ex-post and the ex-ante decisions related to innovation. By delegating authority to a CEO, the owners

effectively lower the number of people the innovator has to bargain with and therefore increase his incentives to disclose internally. Moreover, by restricting the CEO's authority (e.g., restricting the size of the CEO's discretionary budget), the owners can limit and tailor the amount of rents that innovators can extract from the firm.

Obviously, the delegation of authority comes at a cost. Delegation implies that the owners lose control over the decisions in the firm and that they expose themselves to other sources of expropriation. First, the CEO will enjoy an informational advantage vis-a-vis the owners, due to his central role with respect to decisions regarding innovation. The CEO might use this informational advantage either to renegotiate his contract or to leave the firm himself. Second, the incentives of the CEO with respect to innovation in the firm may be different than those of the shareholders.

To what extent can the CEO's compensation package re-align his incentives with those of the owners? We analyze three different compensation schemes for a CEO: (a) a simple base salary that does not include shares of the firm; (b) a scheme that includes a positive share of the firm; and (c) a scheme that is increasing in the firm's *market profits* (i.e., π in the status quo, π_1 if a spin-out forms and 1 if there is internal disclosure).[19]

Let V be the value of the information rent that the CEO can extract in the ex-post renegotiation within the firm if he learns about the innovation.[20] In general, the amount V is a non-decreasing function of his outside option ($\frac{\pi_2}{m+1}$) and non-increasing function of the firm's outside option (π_1). Also, let β be the share the profits included in the CEO's compensation scheme, and let $B \leq 1$ be the budget the CEO can spend in employee's compensation upon intra-firm renegotiation.[21]

Since, in this model of governance structure, the number of the agents in the firm that need to approve an innovation in order for it to be implemented is one (that is, $n = 1$), according to Proposition 1, in the absence of buying-off, the innovator will choose an internal disclosure if and only if $B \geq \pi_2$. In this case, the CEO will buy off innovators if and only if

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[19]Note that the considerations we make for scheme (b) extend trivially to the case in which instead of company stock the CEO receives stock options. For a comprehensive survery and analysis on the topic of CEO compensation, see Jensen and Murphy (2004).

[20]CEO compensation packages usually are approved by a remuneration commitee, which is a subset of the board of directors. This commitee may include outsiders, as well as directors from within the company. We do not model a specific bargaining protocol between the CEO and the owners, but we use the amount V to capture the CEO's payoff at the end of the negotiation.

[21]Then, B measure the CEO's discretion in spending the firm's budget to implement innovation within the firm. If $B = 1$, the CEO has full discretion over the value of the firm.

$$\beta \left[\pi - \frac{B}{m+1} \right] \quad \geq \quad \beta \left(1 - B - V \right) + V \qquad (1)$$
$$= \quad \beta \left(1 - B \right) + \left(1 - \beta \right) V$$

where $\pi - \frac{B}{m+1}$ and $1 - B - V$ are the firm's profits if there is buying off and if there is an internal disclosure, respectively.[22]

Under compensation scheme (a), in which $\beta = 0$, the CEO will always promote internal disclosure within the firm (which occurs if $B \geq \pi_2$), because he will be able to extract the rent V from it. On the other hand, internal disclosure is in the shareholders' interest if $\pi - \frac{B}{m+1} \geq 1 - B - V$. Therefore, it is easy to see that the CEO always tends to innovate too much with respect to the shareholders' interests. Alternatively, when a spin-out is expected (i.e., $B < \pi_2$), the CEO is indifferent between encouraging or discouraging it. In this case, the CEO does not have any incentive to act against the interests of the shareholders.

Under compensation scheme (b), under which $\beta > 0$, it is easy to see that the CEO's incentives and the shareholders' interest become more aligned as β increases. On the other hand, if $B < \pi_2$ and a spin-out is expected, the CEO's interests are aligned with the shareholders' interests for any $\beta > 0$.

Observe that under compensation plan (b), if $\pi - \frac{B}{m+1} > 1 - B - V$, the practice of compensating a CEO with the firm's shares eventually causes the CEO to become more and more conservative. This is because, as β increases, the CEO internalizes the reshuffling effect more and more.

Finally, under compensation plan (c), it is easy to see that a CEO will always promote internal disclosure and prevent spin-outs. In this case, the CEO's incentives may differ from those of the owners even when a spin-out is expected.

Let us focus on plans (a) and (b) and let us turn to the optimal choices of B and β from the sharholders' point of view. If the sharholders set B small enough (the CEO discretion in intra-firm renegotiation is limited), spin-out will always be expected and the shareholders will guarantee themselves π_1 (by setting any small $\beta > 0$). On the other hand,

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[22] This is assuming, for simplicity, that the innovator has all the bargaining power on B with respect to the CEO. None of these considereations depend on this assumption, and B could be substituted by some γB where $\gamma \in [0,1]$ measures the bargaining power of the innovator (and the other players involved in the implementation of the new idea) with respect to the CEO. Equation 1 would become $\beta \left[\pi - \frac{\gamma B}{m+1} \right] \geq \beta \left(1 - \gamma B \right) + V$, and all the considerations made in this section would remain the same.

if B is set to be equal or larger to π_2, either an internal disclosure or a buying off will be induced. If the shareholders wants to induce an internal disclosure, the optimal way to do it is to set $\beta = 0$ (in this way, the CEO will always encourage such an outcome by setting $v = 0$) and $B = \pi_2$. In this way, the shareholders get $1 - \pi_2 - V$.

Finally, if the shareholders want to induce the CEO to buy innovators off, they should set B and β to solve the following problem

$$
\begin{aligned}
\max\nolimits_{B \in [\pi_2, 1], \beta \in [0,1]} \quad & (1 - \beta) \left(\pi - \frac{B}{m+1} \right) \\
s.t. \qquad\qquad\qquad\qquad & \beta \left[\pi - \frac{B}{m+1} \right] \geq \beta \left(1 - B - V \right) + V
\end{aligned}
\tag{2}
$$

Let (B^*, β^*) be the solution of (2). It is easy to see that at the optimum the constraint of problem (2) has to be binding, so $\beta^* = \frac{V}{\pi + B^* \frac{m}{m+1} - 1 + V}$. The comparison of the payoffs π_1 (spin-out formation), $1 - \pi_2 - V$ (internal disclosure) and $(1 - \beta^*) \left(\pi - \frac{B^*}{m+1} \right)$ (buying-off internal disclosure) determines the optimal policy from the point of view of the shareholders. If π_1 dominates the other payoffs, spinout formation should be encouraged by setting B lower than π_2, and β just above zero. If $1 - \pi_2 - V$ dominates the other payoffs, internal disclosure should be encouraged by setting $B = \pi_2$ and $\beta = 0$, while if $(1 - \beta^*) \left(\pi - \frac{B^*}{m+1} \right)$ dominates the other payoffs, the owners of the firm should set $B = B^*$ and $\beta = \beta^*$.

Our analysis has showed that, in order to promote innovation, it is better to lower the number of people involved in the decision-making process related to the implementation of new ideas. However, as firms become larger, the possibility of delegating all the decisions to a unique manager becomes more and more difficult to implement, and the organization of decision-making has to become more hierarchical.

An alternative option available to larger firms is dividing the firm into independent units, each invested with its own decision-making authority–that is, a *flat hierarchy*. One well-known example of a firm that successfully implemented this option is Hewlett Packard. In fact, in the late '50s, Hewlett Packard succeeded in being very innovative by implementing the so-called "HP-way" corporate governance model, a very decentralized and horizontal structure in which single research units were given a large degree of autonomy. Our model suggests an explanation of why this particular structure would encourage innovation internally.[23]

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[23] The link between innovation and decentralization is consistent with the empirical results of Acemoglu and al. (2006), who find that firms closer to the technological frontier are more likely to be decentralized.

On the other hand, there are costs related to a decentralized governance structure. First, splitting the firm into separate units involves a cost in coordinating of the firm's activities. Second, our model suggests another potential cost of such a structure. The decision-makers in each unit, because of their position, will tend to learn ideas, increase their bargaining power vis-a-vis the firm and appropriate more information rents.

6   Conclusion and Further Research

This paper provides a framework for analyzing the interplay between innovation and firm structure. Here, we outline a few directions for further research.

Our model allows one to analyze the life-cycle of firms in industries with high rates of innovation. Consider, for example, the case of independent innovation in a new industry, studied in Section 4. Let us start with a firm founded by $m + 1$ equal partners to develop and bring an initial innovation on the market. As long as the partnership is small enough, any inspired employee will find it optimal to implement his idea within the firm, and the firm will never find it optimal to discourage it. As more new products are introduced, the firm size increases and the firm's ownership becomes more and more dispersed. At a certain critical point, the employees will start to find it optimal to leave the firm and form a spin-out. Our results in Section 4.1.1 imply that in the independent innovation case, the original firm will not prevent spin-out formation. As a result, innovation will be implemented through the formation of new firms, while the original firm will tend to stagnate.

A second extension relates to industry considerations. The focus in this paper has been the firm's concerns regarding the potential competition arising from within. Indeed, our analysis takes a reduced-form approach to competition coming from other firms. The next step should be to incorporate our model in an industry configuration to analyze the interaction between firms in their attitudes towards innovation.

As a motivational example, it is interesting to compare the two distinct cultures that have developed in two regional industrial zones in the United States, namely Silicon Valley in California and Route 128 in Massachusetts. This comparison suggests that different industries may be characterized by different attitudes towards secrecy and information diffusion. Embedding our model in an industry context would allow us to examine whether these cultural differences can be modeled as multiple equilibria in an industry game.

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Appendix

Proof of Proposition 1 Suppose first that $\frac{1}{m+1} \geq \frac{\pi_1}{n}$ (this is always satisfied for n high enough). If the innovator makes an internal disclosure revealing his idea within the firm, his payoff is $M \equiv \min\left[\frac{1}{n+1}, \frac{1}{m+1}\right]$. If the innovator stays silent, his payoff is v. If he leaves the firm he gets $\frac{\pi_2}{m+1}$. Since M is decreasing in n, the employee will always form a spin-out if n is high enough.

If $v < \max\{M, \frac{\pi_2}{m+1}\} \equiv \overline{v}$ then the innovator leaves if and only if

$$\frac{\pi_2}{m+1} > M$$

and discloses the idea within the firm otherwise. If $v > \overline{v}$ then the employee stays silent.

Suppose now that $\frac{1}{m+1} < \frac{\pi_1}{n}$. Then, if the innovator makes an internal disclosure revealing his idea within the firm, his payoff is $\frac{1-\pi_1}{m+1-n}$, while if he forms a spin-out he gets $\frac{\pi_2}{m+1}$. Thus, set $\overline{v} = \max\left\{\frac{1-\pi_1}{m+1-n}, \frac{\pi_2}{m+1}\right\}$ and proceed with the same steps of the previous case.∎

Proof of Proposition 2 Suppose that $n \geq m$. Then, the payoff of both the innovator and any shareholder after an internal disclosure is $\min\left[\frac{1}{n+1}, \frac{1}{m+1}\right] = \frac{1}{n+1}$. If the innovator forms a spin-out, he gets $\frac{\pi_2}{m+1}$ and, by Corollary 1, a spin-out is expected if $\frac{\pi_2}{m+1} < \frac{1}{n+1}$. If the innovator stays silent, he gets v. Then, from the point of view of the shareholders, we have two possible cases.

(i) If $\frac{1}{n+1} > \frac{\pi_2}{m+1}$, we know that if $v < \frac{1}{n+1}$, then the employee will disclose the idea internally. From the point of view of the shareholders, we have that if they decide not to buy the employee off, they will get $\frac{1}{n+1}$, while if they decide to silence him, they have to set $v = \frac{1}{n+1}$, and they get $\frac{\pi - \frac{1}{n+1}}{n}$. The shareholders will silence the employee if and only if $\frac{\pi - \frac{1}{n+1}}{n} < \frac{1}{n+1}$, or $1 - \pi < \frac{n-n}{n+1}$, which implies $\pi > 1$, which is impossible.

(ii) If $\frac{1}{n+1} < \frac{\pi_2}{m+1}$, we know that if $v < \frac{\pi_2}{m+1}$, then the employee will leave and form a spin-out. If the shareholders set $v = \frac{\pi_2}{m+1}$, they prevent this from happening, and they get $\frac{\pi - v}{n} = \frac{\pi - \frac{\pi_2}{m+1}}{n}$, otherwise they get $\frac{\pi_1}{n}$. Then, the buying off of the employee occurs if and only if $\frac{\pi - \frac{\pi_2}{m+1}}{n} > \frac{\pi_1}{n}$, or $\pi - \frac{\pi_2}{m+1} > \pi_1$∎

Proof of Proposition 3 Suppose that $n < m$. From Corollary 1, we know that the innovator never forms a spin-out and, in case of an internal disclosure, each owner of a concentrated firm gets $\max\left[\frac{1}{m+1}, \frac{\pi_1}{n}\right]$. Suppose first that $\frac{1}{m+1} \geq \frac{\pi_1}{n}$. Then, if $\overline{v} = \frac{1}{m+1}$, an owner of the firm gets $\frac{\pi - \overline{v}}{n} = \frac{\pi - \frac{1}{m+1}}{n}$, while if he sets $\overline{v} = 0$, he gets $\frac{1}{m+1}$. Then, there is buying off if and only if $\frac{\pi - \frac{1}{m+1}}{n} > \frac{1}{m+1}$, or $\pi > \frac{n+1}{m+1}$.

Suppose now that $\frac{1}{m+1} < \frac{\pi_1}{n}$. Then, in case of buying off, the innovator has to get $\overline{v} = \frac{1-\pi_1}{m+1-n}$, and each owner of the firm gets $\frac{\pi - \overline{v}}{n} = \frac{\pi - \frac{1-\pi_1}{m+1-n}}{n}$. If the firm sets $v = 0$, there will be a renegotiation where each owner will get $\frac{\pi_1}{n}$. Then, the buying off occurs if and only if $\frac{\pi - \frac{1-\pi_1}{m+1-n}}{n} > \frac{\pi_1}{n}$, or $\pi_1 < \frac{\pi(m+1-n)-1}{m-n}$ ■